CLAIMS

What is claimed is:

1. An antenna comprising:

a dielectric cavity within a semiconductor substrate having walls defined by a plurality of vias through the substrate;

a gas cavity external to the substrate aligned with the dielectric cavity; and

a conductive feed disposed on the substrate across the cavities.

2. The antenna of claim 1 wherein a ground plane side of the substrate is devoid of ground plane conductive material substantially between the walls of the dielectric cavity.

3. The antenna of claim 2 wherein the antenna is a slot antenna, and wherein the feed comprises a microstrip feed line disposed on the substrate across a slot over the cavities, and

wherein the slot comprises a rectangular region without conductive material on a circuit side of the substrate over the dielectric cavity.

4. The antenna of claim 4 wherein the microstrip feed line is disposed on the ground plane side of the substrate across the slot.

5. The antenna of claim 1 wherein the antenna is a dipole antenna further comprising:

a first pole comprising conductive material on a ground plane side of the substrate disposed over the cavities; and

a second pole comprising conductive material on a circuit side of the substrate disposed over the cavities,

wherein the plurality of vias and one of the poles are electrically coupled to a ground, and

wherein the other of the poles is coupled with the conductive feed.

6. The antenna of claim 2 wherein the vias electrically couple a ground plane conductor of a ground plane side of the substrate with conductive material on a circuit side of the substrate.

7. The antenna of claim 6 wherein the substrate comprises a dielectric material between the ground plane conductor and the conductive material, the dielectric being one of Gallium Arsenide, Silicon, and Indium Phosphate.

8. The antenna of claim 2 wherein the gas cavity has air therein.

9. The antenna of claim 2 wherein the plurality of vias define the dielectric cavity as a rectangular dielectric cavity within the substrate having rectangular dimensions selected to resonate at a millimeter-wave frequency.

10. The antenna of claim 9 wherein the dimensions of the gas cavity are greater than dimensions of the dielectric cavity and selected to be non-resonant at the millimeter-wave frequency, and

wherein a width of the gas cavity is selected to permit substantially an evanescent mode to exist within the gas cavity.

11. The antenna of claim 2 wherein the substrate is adhered to a conductive plate, and wherein the gas cavity is located within the conductive plate

12. The antenna of claim 1 wherein the feed is one of a microstrip feed line, a coplanar waveguide feed, a parallel line feed, a slot line feed.

13. The antenna of claim 2 wherein the antenna comprises a patch antenna comprising conductive material to form a patch on a circuit side of the substrate, the patch being disposed over the dielectric cavity and electrically coupled to the conductive feed.

14. The antenna of claim 2 wherein the antenna comprises a spiral antenna comprising conductive material to form a spiral on a circuit side of the substrate,

the spiral being disposed over the dielectric cavity and electrically coupled to the conductive feed.

15. The antenna of claim 2 wherein the antenna comprises a monopole antenna comprising conductive material to form a monopole on a circuit side of the substrate, the monopole being disposed over the dielectric cavity and electrically coupled to the conductive feed.

16. The antenna of claim 2 wherein the antenna comprises a stub antenna comprising conductive material to form an open-ended stub on a circuit side of the substrate, the stub being disposed over the dielectric cavity and electrically coupled to the conductive feed.

17. The antenna of claim 10 wherein the gas cavity is machined to have a first set of substantially semicircular opposite walls, a second set of substantially parallel opposite walls, and a substantially flat bottom.

18. A reflect-array antenna comprising:

a conductive plate; and

a plurality of unit cells adhered to the conductive plate, wherein each unit cell comprises:

a receive antenna to receive spatially-fed millimeter-wave signals of a first polarization; and

a transmit antenna to re-transmit the received signals with a second polarization,

wherein the receive antenna and the transmit antenna each comprises:

a dielectric cavity within a semiconductor substrate having walls defined by a plurality of vias through the substrate; and

a gas cavity within the conductive plate aligned with the dielectric cavity.

19. The reflect-array antenna of claim 18 wherein each unit cell further comprises one or more power amplifiers to amplify the received signals and provide the amplified signals to the transmit antenna for retransmission.

20. The reflect-array antenna of claim 19 wherein the conductive plate is to serve as a heat sink for the unit cells.

21. The reflect-array antenna of claim 20 wherein the receive and transmit antennas are slot antennas,

wherein the first and second polarizations are orthogonal, and

wherein a slot of the receive antenna is orthogonally positioned with respect to a slot of the transmit antenna.

22. The reflect-array antenna of claim 21 wherein the plurality of unit cells is to generate a high-power coherent wavefront.

23. The reflect-array antenna of claim 21 wherein one or more of the plurality of unit cells are fabricated on more than one semiconductor wafer, the semiconductor wafers tiled together and adhered to the plate

24. The reflect-array antenna of claim 23 wherein the semiconductor wafers are arranged on a substantially flat surface of the plate.

25. The reflect-array antenna of claim 23 wherein the semiconductor wafers are arranged on a curved surface of the plate.

26. The reflect-array antenna of claim 21 wherein the plurality of unit cells is fabricated on a semiconductor wafer which is adhered to a substantially flat surface of the plate.

27. The reflect-array antenna of claim 18 wherein a ground plane side of the substrate is devoid of ground plane conductive material substantially between the walls of the dielectric cavity,

wherein the antenna comprises a slot antenna further comprising a microstrip feed line disposed on the substrate across a slot over the cavities, and

wherein the slot comprises a rectangular region without conductive material on a circuit side of the substrate over the dielectric cavity.

28. The reflect-array antenna of claim 27 wherein the vias electrically couple a ground plane conductor of a ground plane side of the substrate with conductive material on a circuit side of the substrate, and

wherein the substrate comprises a dielectric material between the ground plane conductor and the conductive material, the dielectric being one of Gallium Arsenide, Silicon, and Indium Phosphate.

29. The reflect-array antenna of claim 27 wherein the plurality of vias define the dielectric cavity as a rectangular dielectric cavity within the substrate having rectangular dimensions selected to resonate at a millimeter-wave frequency,

wherein the dimensions of the gas cavity are greater than dimensions of the dielectric cavity and selected to be non-resonant at the millimeter-wave frequency, and

wherein a width of the gas cavity is selected to permit substantially an evanescent mode to exist therein.

30. The reflect-array antenna of claim 18 wherein the gas cavity is machined to have a first set of substantially semicircular opposite walls, a second set of substantially parallel opposite walls, and a substantially flat bottom.

31. A millimeter-wave transmission system comprising:

a reflect-array antenna to provide a high-power substantially coherent wavefront from a spatially-fed low power source; and

a collimator to collimate the high-power wavefront and generate a substantially planar wavefront,

wherein the reflect-array antenna comprises:

a plurality of unit cells adhered onto the conductive plate, wherein each unit cell comprises:

a receive antenna to receive spatially-fed millimeter-wave signals of a first polarization; and

a transmit antenna to re-transmit the received signals with a second polarization,

wherein the receive antenna and the transmit antenna each comprises:

a dielectric cavity within a semiconductor substrate having walls defined by a plurality of vias through the substrate; and

a gas cavity within a conductive plate aligned with the dielectric cavity.

32. The system of claim 31 wherein each unit cell further comprises one or more power amplifiers to amplify the received signals and provide the amplified signals to the transmit antenna for retransmission.

33. The system of claim 31 wherein the receive and transmit antennas are slot antennas,

wherein the first and second polarizations are orthogonal, and

wherein a slot of the receive antenna is orthogonally positioned with respect to a slot of the transmit antenna.

34. The system of claim 33 wherein a ground plane side of the substrate is devoid of ground plane conductive material substantially between the walls of the dielectric cavity,

wherein the antennas further comprise a microstrip feed line disposed on the substrate across each slot over the cavities, and

wherein the slots comprise a rectangular region substantially without conductive material on a circuit side of the substrate over the dielectric cavities.

35. The system of claim 31 wherein the collimator comprises a reflective plate.

36. The system of claim 31 wherein the collimator comprises a millimeter-wave lens.

37. The system of claim 31 wherein the collimator comprises a plurality of individual antenna elements arranged circumferentially around a center point, each antenna element to receive and transmit signals to provide approximately a 180-

degree phase shift, the antenna elements being sized and shaped to receive a high-power substantially spherical wavefront and generate the planar wavefront.

38. A method of fabricating a reflect-array antenna comprising:

machining air cavities in a conductive plate;

providing unit cells each having a receive antenna and a transmit antenna thereon, the antennas having dielectric cavities within a semiconductor substrate; and

adhering the unit cells to the conductive plate to substantially align with the air cavities with the dielectric cavities.

39. The method of claim 38 wherein providing comprises providing unit cells wherein the dielectric cavities have walls defined by a plurality of vias through the substrate, and wherein a ground plane side of the substrate is devoid of ground plane conductive material substantially between the walls of the dielectric cavity.

40. The method of claim 39 wherein machining comprises machining the gas cavity to have a first set of substantially semicircular opposite walls, a second set of substantially parallel opposite walls, and a substantially flat bottom.

41. The method of claim 38 wherein machining comprises machining an epoxy well in the plate, and wherein adhering comprises filling the well with an adhesive to adhere an amplifier portion of the substrate to the plate.

42. The method of claim 38 wherein adhering comprising adhering the substrate to the plate with indium solder.